Instruction and Maintenance Manual

RADIOLOGICAL SURVEY METER

OCD Item No. CD V-715, Model No. 1A

Manufactured 1962

APPROX
20 PCS

THE VICTOREEN INSTRUMENT COMPANY
5806 Hough Avenue • Cleveland 3, Ohio

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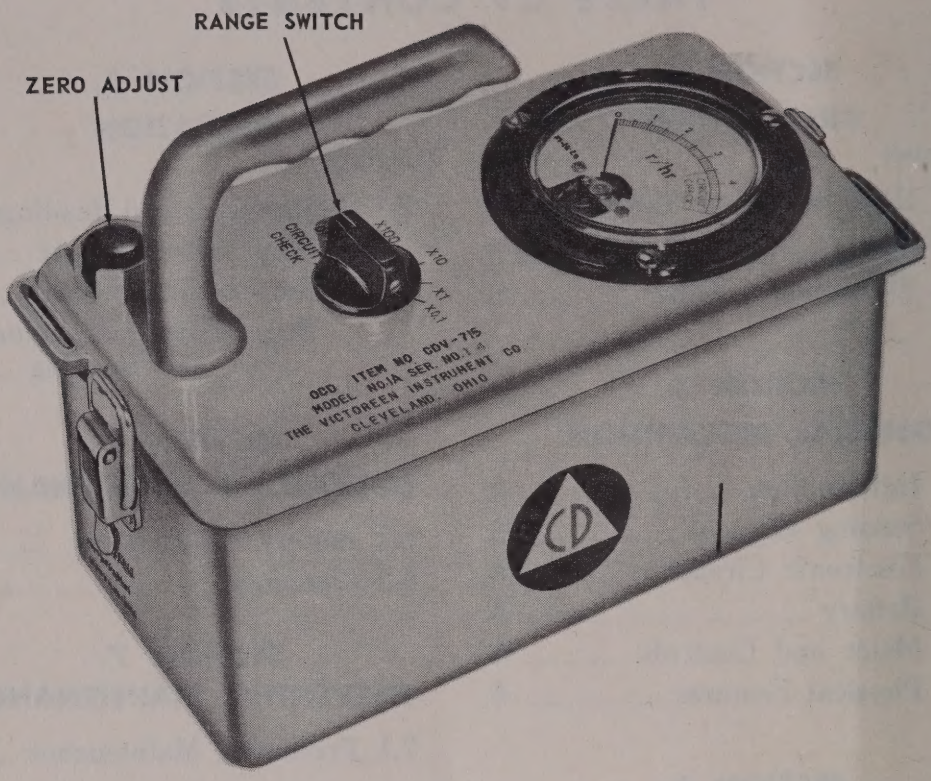


Figure 1. View of CD V-715, Showing Operating Controls

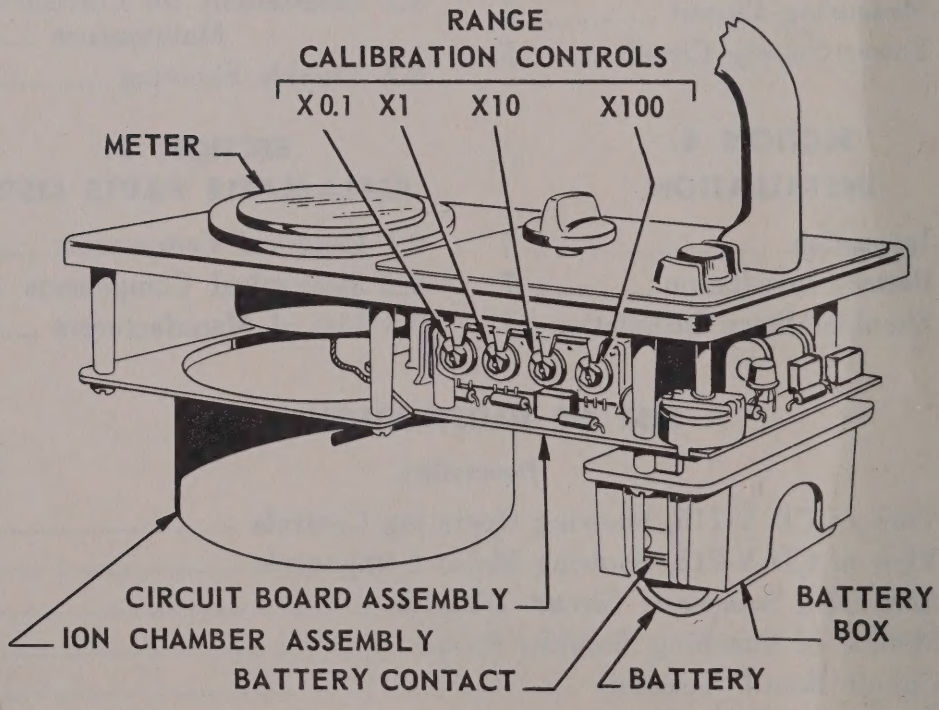


Figure 2. View of CD V-715, Showing Major Components

1. PRECAUTIONS

1.1 HIGH IMPEDANCE CIRCUITRY:

The high megohm resistors, electrometer tube, ceramic switch-wafer, and chamber feed-thru and guard-ring comprise the high impedance circuitry of the CD V-715. Any accumulation of dirt or grease on these parts will contribute to leakage currents that will cause upscale readings which will be most evident on the X0.1 range. Therefore, it is desirable that these parts be handled as little as possible. These parts may be cleaned with a good quality solvent such as alcohol applied with a soft brush. The solvent should be free of any impurities or contaminants which might leave a residual film as the solvent evaporates.

1.2 SEMI-CONDUCTOR COMPONENTS (DIODES AND TRANSISTORS):

The semi-conductor components used in the CD V-715 may be damaged by prolonged exposure to excessive heat. When replacing any of these components the soldering operations should be accomplished as quickly as possible. Holding the lead between the component and the soldering point with a pair of pliers will decrease the heat transmitted to the component during the soldering operation.

1.3 ELECTROMETER TUBE:

When checking for a possible open filament of the electrometer tube, be certain to use an ohmmeter which has an output current of less than 10 ma when used to measure resistances of about 100 ohms.

2. GENERAL DESCRIPTION

2.1 INTRODUCTION:

The CD V-715, Model 1A, Victoreen Model 815, is a portable monitoring instrument which measures gamma radiation dose rates as high as 500 roentgens per hour. It is designed to be used by radiological Civil Defense personnel in determining radioactive contamination levels that may result from an enemy attack or other nuclear disasters.

Instrument accuracy on any of its four ranges is within ±20% of the true dose rate from CO^{60} gamma radiation. This accuracy is maintained throughout a temperature range of —20°F to +125°F, relative humidities to 100% and at altitudes from sea level to 25,000 feet.

2.2 SENSING ELEMENT:

The detecting element in the CD V-715 is an hermetically sealed ionization chamber. This chamber is located in the lower front portion of the instrument, as shown in Figure 2, to make the instrument equally sensitive to radiation from the bottom and front. The ionization chamber plus the instrument case will together total more than 1000 mg/cm^2 in effective thickness to make the instrument insensitive to beta rays lower than 2 Mev in energy. The ionization chamber is hermetically sealed to eliminate changes in sensitivity due to changes in air pressure resulting from altitude changes, temperature changes, and moisture effects.

2.3 ELECTRONIC CIRCUITRY:

All electrical components which make up the circuitry are fastened to a printed circuit board. The circuitry serves to measure the minute current from the ionization chamber which indicates the presence of ionizing radiation. The high impedance components are housed in a gasketed light-tight enclosure for protection and shielding.

2.4 BATTERY:

The CD V-715 is powered by one "D" size flashlight cell (NEDA 13). The battery will operate the instrument continuously for over 150 hours and much longer on an intermittent basis.

2.5 METER AND CONTROLS:

The CD V-715 uses a ruggedized, sealed meter to meet the instrument requirements for water-tightness, shock and vibration resistance. Two controls are provided. One control is a range switch which turns the instrument on, checks its operation and serves to select the proper range. The second is a zero control which is used to adjust the instrument to assure proper reading.

2.6 PHYSICAL FEATURES:

The instrument is housed in a die cast aluminum and drawn steel case with a cast canti-lever handle keyed and bolted in place. Carrying strap hooks and the zero control guard are permanently molded in. The nameplate and control knob information is indelibly engraved into the case top. Two snap type pull catches serve to fasten the bottom of the case to the top. Water-tightness is ensured by the closed cellular sponge rubber gasket between the case top and bottom. The instrument is operable with the case bottom removed. The battery is housed in a high-impact resistant plastic case which cannot be corroded by leaking battery fluids. The battery contacts are readily replaceable without tools to facilitate cleaning or replacement. The battery box is designed to be mechanically selective so that the battery cannot be inserted backwards. The instrument is approximately 9" long, 4½" wide and 4" high, excluding the handle. The instrument weight is 3¼ pounds and it will float in water.

3. THEORY OF OPERATION

3.1 IONIZATION CHAMBER:

The detecting element of the CD V-715 is an hermetically sealed air filled ionization chamber. It consists of a conducting cylindrical container called the shell and a thin aluminum disc called the collector, located in the center of the shell. The shell is the positive electrode and the collector the negative electrode. The collector is insulated from the shell by an extremely high resistance feed-thru insulator. A voltage, called the collecting voltage, is applied between these two chamber electrodes. This makes the shell approximately 48 volts positive with respect to the collector. See Figure 3. Radiation, passing through the chamber, causes ionization of the air molecules contained within the chamber. These charged particles or ions are attracted to the chamber electrode having the opposite charge, i.e., positive

ions move toward the center electrode of the chamber and negative ions move toward the shell.

The arrival of these ions at the chamber electrode constitutes a current which is proportional to the number of ions collected. Since the number of ions created is proportional to the radiation intensity, this ionization current is proportional to the radiation intensity in the ionzation chamber.

3.2 INPUT CIRCUIT:

The ionization current is extremely small — about 7 micro-microamperes at 0.5 r/hr which is full scale on the most sensitive range. It flows through a very high resistance (220,000 megohms) high megohm resistor connected to the collector of the ionization chamber as shown in Figure 3. This ionization current develops a voltage drop of about 1.4 volts across the high megohm resistor with the polarity as shown.

The voltage developed is applied to the grid of a vacuum tube for amplification. Any of the minute ionization current flowing to the grid of the tube instead of through the high megohm resistor would result in amplification of only a portion of the signal. A special vacuum tube called an electrometer tube capable of amplifying voltages at extremely small grid currents is used to prevent this error. This tube is connected as a triode as shown in Figure 3.

3.3 MEASURING CIRCUIT:

In order to permit zeroing the instrument in a radiation field, a section of the range switch is used to short circuit the high megohm resistor and prevent any ionization signal from being sensed by the input circuit on the "ZERO" position. A "ZERO" control is located on the top of the instrument for balancing out static plate current. This balancing is accomplished by changing electrometer tube voltages by means of the potentiometer, R2. The measurement of the grid voltage of the electrometer tube is accomplished by metering the change in plate current directly. The static plate current is cancelled by running a reverse current, supplied by the battery BT1, through the meter. The magnitude of this current is fixed by the bucking resistor R12.

Sensitivity of the instrument is changed by switching high megohm resistors, which is accomplished by the range switch.

3.4 POWER SUPPLY CIRCUIT:

Three separate d.c. voltages are required by the measuring circuit as shown in Figure 3. These are the plate voltage supply of 10.5 volts, the grid bias supply of - 3.8 volts and the ion chamber collecting voltage of 50 volts.

All of these voltages are obtained from a transistor oscillator circuit. The transistor Q1, driven by the battery BT1 through the lower portion of the primary of transformer T1, constitutes this oscillator, with feed-back to the base of Q1 from the upper portion of the transformer via condenser C1 serving to sustain oscillation. The three output voltages are rectified from the a.c. output of the secondary of T1, by rectifiers CR1, CR2, and CR3, as shown.

Variations in output voltage with battery voltage and load current changes are prevented by the regulating network of R5 and R6. This network feeds back a portion of the plate supply voltage to the base of the transistor Q1

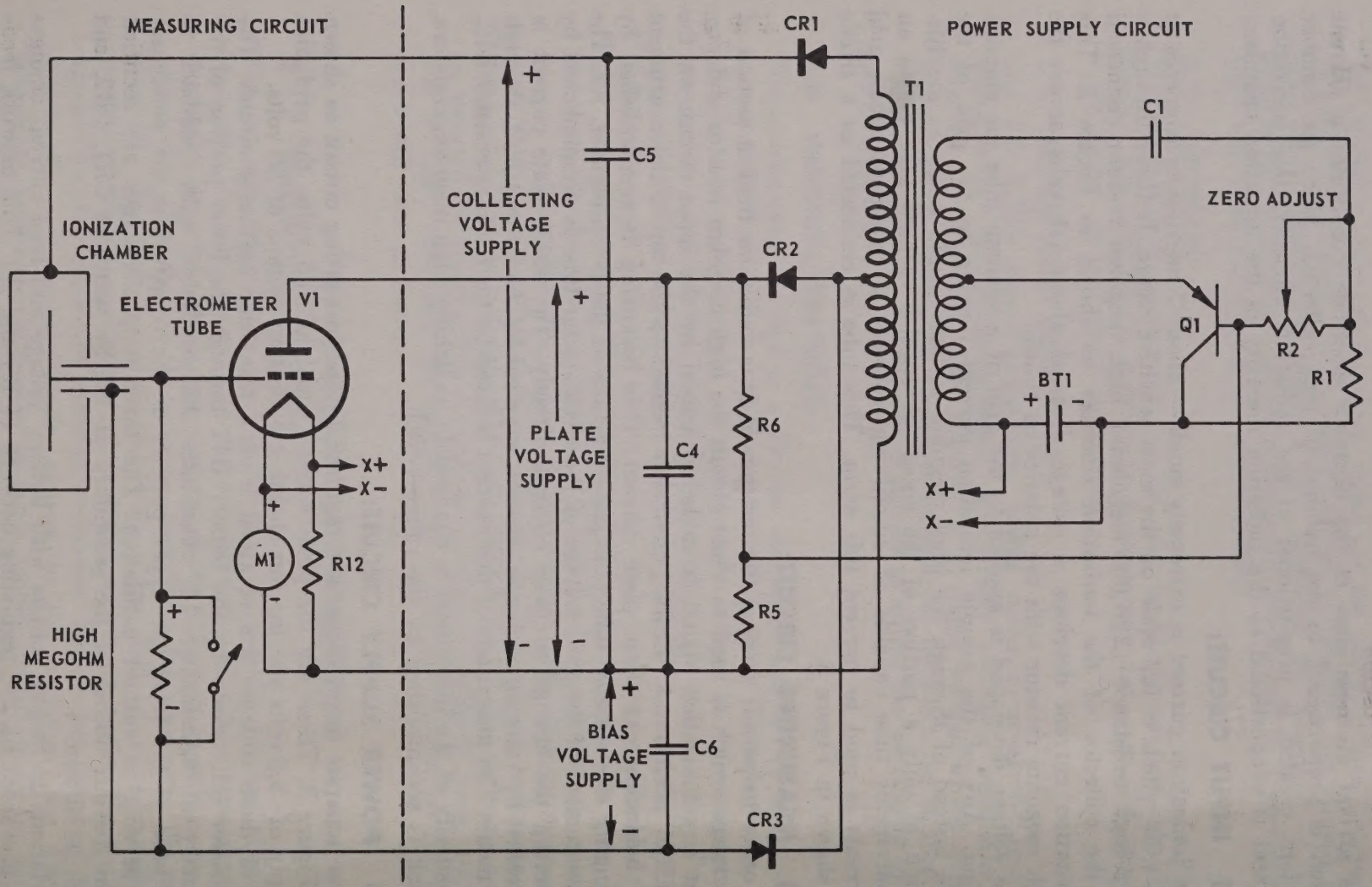


Figure 3. Simplified Schematic Circuit Diagram

so as to control the bias current and hence, the battery current and magnitude of oscillation in such a fashion as to keep the plate voltage constant. This regulation method limits the battery drain through Q1 when the battery is new and is hence a method contributing to long battery life.

4. INSTALLATION

4.1 INSPECTION:

The instrument is shipped with battery and carrying strap removed from the instrument and packed separately. Inspect the battery for possible leakage before installation. Do not install a leaking battery. Inspect the instrument for damage in shipment. If damage is apparent the battery should not be installed, thus preventing further damage due to possible short circuits.

4.2 BATTERY INSTALLATION:

Open the instrument by snapping open the pull catch at each end of the case and separating the top from the case bottom. This exposes the battery box as shown in Figure 2. Insert the battery in the battery box observing the indicated polarity. (The battery box is designed to be mechanically selective so that the battery cannot be inserted with reversed polarity). Close the instrument by aligning the top with the case bottom and squeezing together gently. Snap the pull catches closed.

4.3 SHOULDER STRAP INSTALLATION:

The carrying strap and two carrying strap slides and clips are packed separately. They are affixed to the cast-in carrying strap loops in the end of the case as shown in Figure 4, and the length is adjusted to suit the operator.

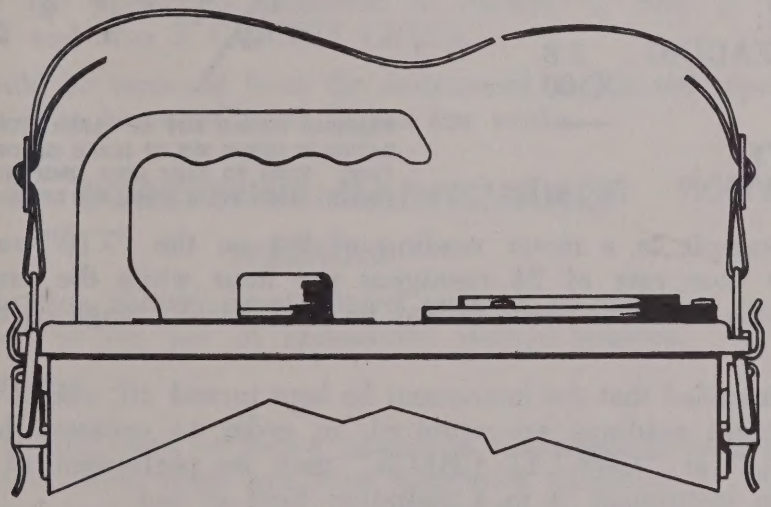


Figure 4. Method of Attaching Shoulder Straps

5. OPERATION

5.1 ADJUSTMENTS AND READINGS:

There are three simple basic steps recommended for proper operation of the CD V-715. They are described as follows:

Step 1. Zero Adjust

Turn the instrument on by turning the range switch from "OFF" to the

"ZERO" position. Wait about a minute to allow the electrometer tube to warm up, then orient the "ZERO" control until the meter needle indicates zero on the meter.

CAUTION

If the instrument is not zeroed properly, readings taken on any of the four ranges will be erroneous.

Step 2. Circuit Check

Turn the range switch counter clockwise from the "ZERO" position through the "OFF" position to the "CIRCUIT CHECK" position. This position is spring-loaded to return to "OFF". The range switch must be held in this position for the circuit check. The meter should read in the red outlined section labeled "CIRCUIT CHECK". If it does not, either the battery is low or trouble exists in the circuit. See Sections 6 and 8 for proper procedures. Make certain the instrument is zeroed before making the circuit check.

A low or dead battery is indicated by inability to zero the instrument or by a meter reading below the check band when the range switch is in the "CIRCUIT CHECK" position.

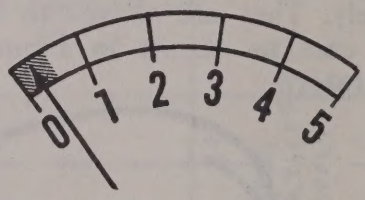
Step 3. Range Selection and Reading

Turn the range switch to the "X100, X10, X1, or X0.1" range as necessary to obtain an upscale reading on the meter.

The meter reading observed must be multiplied by the factor indicated by the position of the range switch to obtain the radiation dose rate in roentgens per hour (r/hr).

EXAMPLE:

METER READING	3.8
RANGE	X100
INTENSITY OF RADIATION	380 r/hr



READINGS SHOULD NOT BE TAKEN WITH POINTER INDICATING IN LOWER 10% OF SCALE (SHADED IN ILLUSTRATION). TURN TO NEXT MOST SENSITIVE RANGE UNTIL POINTER INDICATES IN UPPER 90% OF SCALE (UNSHADED).

Another example is a meter reading of 2.4 on the "X10" range which indicates a dose rate of 24 roentgens per hour while the same reading obtained with the instrument turned to the "X100" range corresponds to 240 r/hr.

It is recommended that the instrument be kept turned off, except for periods where frequent readings are required, in order to conserve battery life. The "ZERO" or "CIRCUIT CHECK" may be performed at any time, whether the instrument is in a radiation field or not.

6. OPERATOR'S MAINTENANCE

6.1 BATTERY REPLACEMENT:

Battery replacement is indicated whenever the instrument can no longer be zeroed or when the meter indicates below the "CIRCUIT CHECK" band. To replace the battery, snap open the pull catches and separate the two halves of the instrument. Remove the battery and install a new battery as indicated in Para. 4.2 BATTERY INSTALLATION. If a battery tester is available the battery may be checked in accordance with Para. 8.3. The

battery should be removed from the instrument and stored separately if the instrument is to be stored more than a few weeks.

6.2 CLEANING:

WARNING

Do not use cleaning solvents on the plastic parts. To clean the case, use soap and water. If the battery has leaked, remove the case bottom and fill with warm water. The battery spillage will be loosened in a short while and can be rinsed out. Be careful not to soak off the circuit diagram or the CD decal.

7. PREVENTIVE MAINTENANCE

7.1 PREVENTIVE MAINTENANCE:

It is recommended that the preventive maintenance procedures be carried out once a month when the instrument is in use, and about once every six months when the instrument is in storage.

Preventive maintenance should be carried out as follows:

a. Remove the battery, clean battery contacts and battery terminals if necessary and remove any corrosion present.

b. Replace the battery making certain that it makes good contact and exceeds minimum voltage.

c. Perform the operations indicated in Section 5, Step 1. ZERO ADJUST and Step 2. CIRCUIT CHECK.

The battery should be removed from the instrument and stored separately if the instrument is to be stored more than a few weeks.

8. CORRECTIVE MAINTENANCE

WARNING

Calibration should be attempted only by personnel trained in the use of radioactive isotope sources.

8.1 CALIBRATION:

The CD V-715 is calibrated by being placed in a gamma radiation field of known dose rate. Such fields are most commonly produced by using a radioactive material such as radium or Cobalt^{60}. As an example, a 1 curie radium source will produce a radiation dose of 4 r/hr, at a distance of 18.1 inches. The CD V-715 should read this dose rate when so positioned with the center of the ion chamber at this distance. If it does not, the instrument should be recalibrated. This is accomplished by removing it from its case and adjusting the individual "CAL" controls for the corresponding ranges so that the proper reading is indicated on the meter. The distance from the center of the CD V-715 ionization chamber to the calibrating source should be at least 12 inches to obtain reasonable geometry (reasonably uniform radiation intensity over the volume of the ionization chamber).

If it is necessary to remove the instrument from its case to adjust the "CAL" controls, the instrument must be replaced in the case to obtain a correct reading.

8.2 DISASSEMBLY FOR CORRECTIVE MAINTENANCE:

a. Release the snap action catches and remove the instrument from the case bottom.

b. Remove the battery from the battery box.

c. Remove the two screws which secure the battery box to the instrument top. Swing the battery box away from the circuit board. Wiring between the battery box and the circuit board prevents complete separation of the battery box.

d. Remove the four screws which secure the chamber to the instrument top.
Note: At this point the instrument (with battery) will operate on ZERO and CIRCUIT CHECK ranges and the circuit board is completely exposed for trouble shooting.

e. Remove the meter connecting leads at the meter terminals.

f. Remove the knob from the ZERO control. It is not necessary to remove the range switch knob.

g. Remove the other two screws holding the circuit board to the case top.

h. Remove the circuit board. This is most easily accomplished by pressing on the ZERO control shaft and pulling lightly on the board.

i. Remove the two screws holding the circuit shield box to the circuit board.
CAUTION: When reassembling, tighten screws so that gasket is compressed only ½ its thickness, that is, 1/32 inch.

j. Remove the circuit shield box. The instrument is now completely disassembled. Reassembly of the instrument is the reverse of the disassembly procedure.

CAUTION

Before beginning reassembly make certain the range switch and the switch-wafer is oriented in the *OFF* position.

8.3 TROUBLE SHOOTING:

The majority of the electrical components of the CD V-715 are standard parts familiar to electronic technicians and are readily checked by conventional means. The electrometer tube, the high megohm resistors, the ion chamber insulator and the ceramic switch section are the only components requiring special precaution. These components are all part of the high resistance input circuit. THE INSULATING PORTIONS OF THESE FOUR COMPONENTS SHOULD NOT BE HANDLED. They should be touched only with clean tools when repairs are made. If surface leakage on any of these items is suspected, cleaning with clean alcohol using a clean camel hair brush is recommended. Avoid solder flux splattering on these components when repairs are made.

The battery as well as the measuring circuit are checked by the "CIRCUIT CHECK". If trouble exists, batteries should be checked with a battery tester.

Circuit malfunctions may be traced with the aid of the schematic circuit diagram, Figure 6. Voltage measurements shown on this diagram are measured with respect to point* and are those obtained with a voltmeter having a sensitivity of 20,000 ohms per volt. Such voltage checks should be taken with the instrument range switch turned to the "ZERO" range and with the zero control adjusted so that the instrument reads zero.

The following troubles and corrective action are presented as an aid to trouble shooting:

TROUBLE SHOOTING CHART

Trouble and Cause	*Corrective Action*
NO READING	
Battery Low	Replace the Battery
Corroded Battery Contacts	Clean or Replace the Contacts
Meter Damaged	Replace Meter
Chamber Damaged	Replace Chamber
Open Connection	Inspect Solder Joints
METER WILL NOT ZERO	
(Reads Upscale)	
Tube Defective	Replace Tube
METER WILL NOT ZERO	
(Reads Downscale)	
Battery Low	Replace Battery
Corroded Battery Contacts	Clean or Replace Contacts
Defective Tube	Check Tube Filament
Transformer Defective	Replace Transformer
INSTRUMENT READS LOW	
Calibration Control Disturbed	Check Calibration
Defective Tube	Replace Tube
Meter Damaged	Replace Meter
Defective Chamber	Replace Chamber
Dirty High Resistance Components	Clean High Resistance Components
INSTRUMENT READS HIGH	
Calibration Control Disturbed	Check Calibration
Damaged High Megohm Resistor	Replace High Megohm Resistor
Dirty High Resistance Components	Clean High Resistance Components

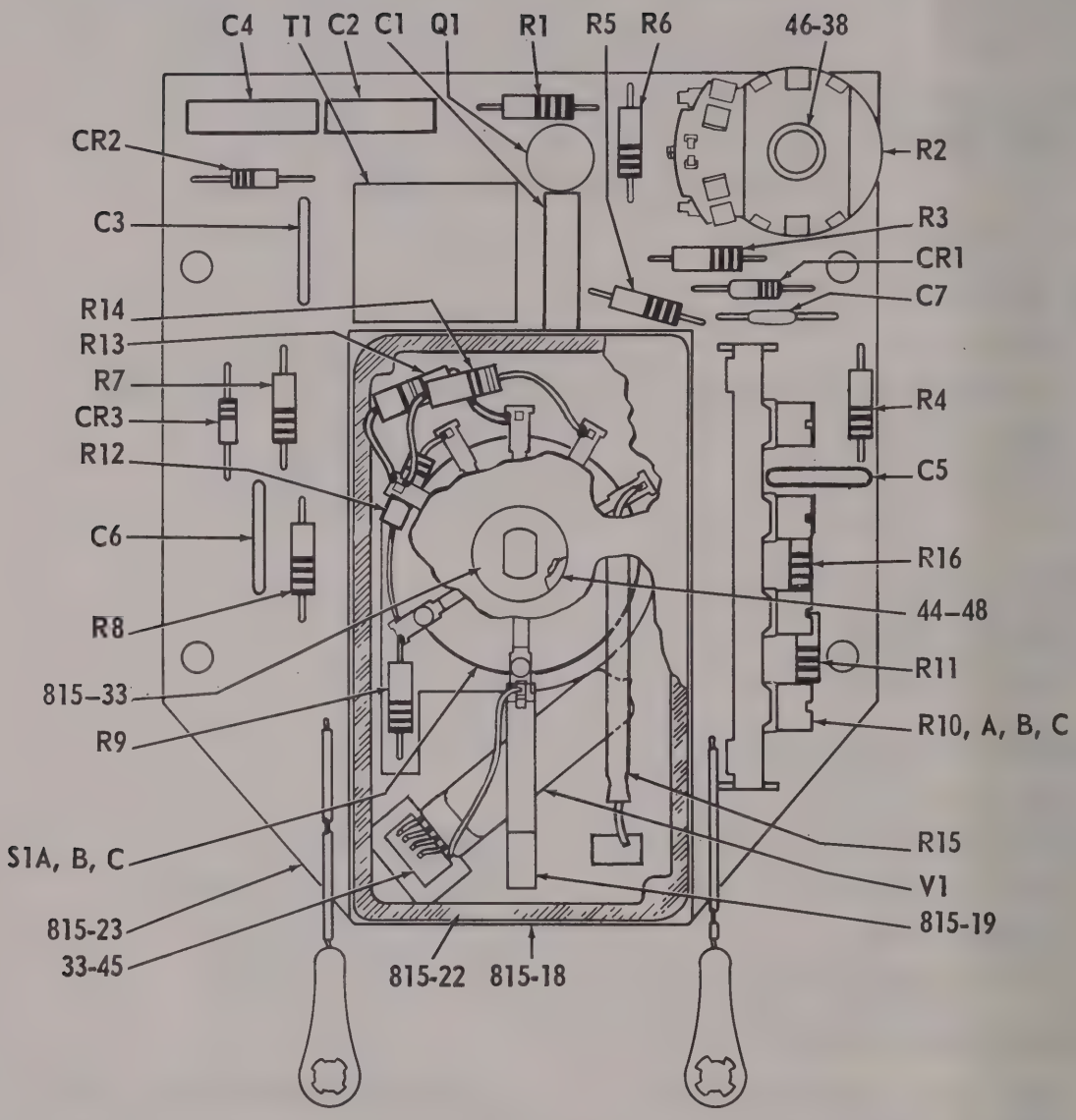
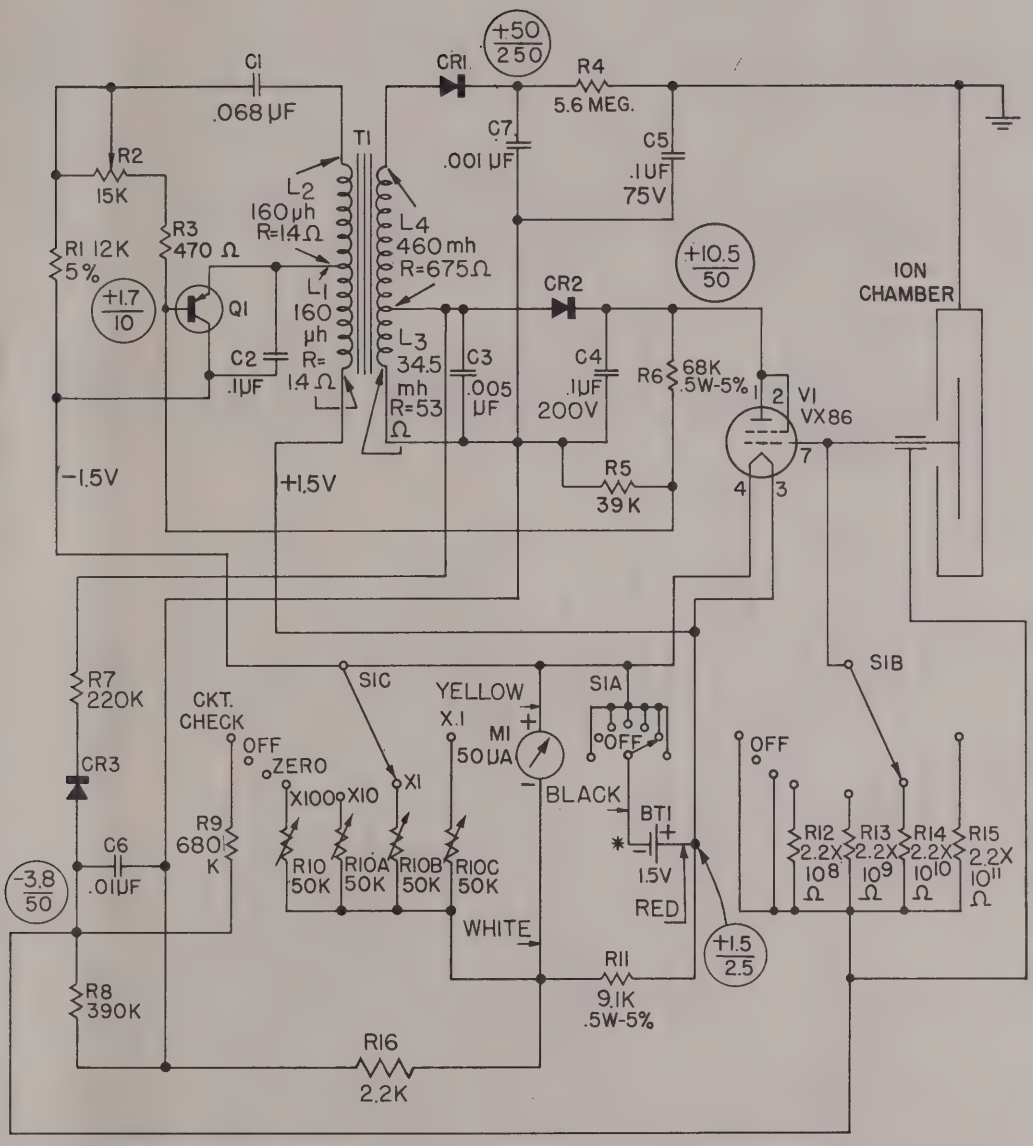


Figure 5. Circuit Board Assembly



VOLTAGE / RANGE — VOLTAGES REF TO — BATT. TERM.(*) INSTRUMENT OPERATING ON ZERO RANGE WITH ZERO CORRECTLY ADJUSTED. VOLTAGES MAY VARY ±20% FROM INSTRUMENT TO INSTRUMENT.

TRANSFORMER INDUCTANCES MEASURED ON IKC BRIDGE WITH ALL OTHER WINDINGS FREE.

Figure 6. Schematic Circuit Diagram

9. REPLACEABLE PARTS LIST

9.1 Electrical Components.

Circuit Symbol	Description	Function	Manufacturer	Mfg. Part No.	Victoreen Part No.	Quantity Per Equipment	*Quantity For Maintenance
C1	Capacitor: .068 ufd; 200V	Oscillator Base Coupling Capacitor	John E. Fast Co.	F307 C683 M	21-408	1	1
C2	Capacitor: .1 ufd; 200V	R. F. By-pass Capacitor	John E. Fast Co.	F307 C104 M	21-407	2	2
C3	Capacitor: .005 ufd; 50V; 20%	Oscillator Tank Capacitor	Aerovox	——	21-387	1	1
C4	Same as C2	5886 Plate Supply Filter Capacitor	John E. Fast Co.	——	——	—	—
C5	Capacitor: .1 ufd; 75V	Chamber Voltage Filter Capacitor	Radio Materials Corp.	TA	21-415	1	1
C6	Capacitor: .01 ufd; 150V	Grid Bias Voltage Filter Capacitor	Aerovox	——	21-257	1	1
C7	Capacitor: .001 ufd; Ceramic; 100V	Chamber Voltage Filter Capacitor	Aerovox	——	21-404	1	1
M1	Meter Assembly: 50 ua	Dose Indication	Victoreen	——	815-28	1	5
Q1	Transistor	Power Supply Oscillator	G.E.	4JXID753	23-34	1	2
R1	Resistor: 12K; .5W; 5%	Transistor Base Bias Resistor	IRC	GBT-½	185-338	1	1
R2	Potentiometer: 15K; .5W	Zero Adjust Oscillator Base Bias	CTS Corp.	WP-45 Spl.	22-160	1	1
R3	Resistor: 470 Ohms; .5W; 10%	Transistor Base Current Limiter	IRC	GBT-½	185-251	1	1
R4	Resistor: 5.6 Meg; .5W; 10%	Decoupling Filter, Chamber Voltage Supply	IRC	GBT-½	185-406	1	1
R5	Resistor: 39K; .5W; 10%	Voltage Divider, Oscillator Regulator Circuit	IRC	GBT-½	185-244	1	1
R6	Resistor: 68K; .5W; 5%	Voltage Divider, Oscillator Regulator Circuit	IRC	GBT-½	185-156	1	1
R7	Resistor: 220K; .5W; 10%	Series Limiter, Grid Bias Supply	IRC	GBT-½	185-331	1	1
R8	Resistor: 390K; .5W; 10%	Load Resistor, Grid Bias Supply	IRC	GBT-½	185-306	1	1
R9	Resistor: 680K; .5W; 10%	Circuit Check, Shifts Grid Bias	IRC	GBT-½	185-337	1	1
R10	Potentiometer: 50K	Range Cal. Pot.—X100	CTS of Ashville	X-154	22-165	1	1
R10A	Section of R10; 50K	Range Cal. Pot.—X10	———	——	——	—	—
R10B	Section of R10; 50K	Range Cal. Pot.—X1	———	——	——	—	—
R10C	Section of R10; 50K	Range Cal. Pot.—X0.1	———	——	——	—	—
R11	Resistor: 9.1K; .5W; 5%	Zero Signal Bucking Current Limiter	IRC	GBT-½	185-214	1	1
R12	Resistor: 2.2×10^8 Ohms; 20%	High Megohm—X100	Victoreen	185-1372	185-1372	1	1

*Quantity of Plant and Maintenance Supply Parts Based on Five Instruments For One Year of Operation.

9.1 Electrical Components (cont'd)

Circuit Symbol	Description	Function	Manufacturer	Mfg. Part No.	Victoreen Part No.	Quantity Per Equipment	*Quantity For Maintenance
R13	Resistor: 2.2×10^9 Ohms; 20%	High Megohm—X10	Victoreen	185-1371	185-1371	1	1
R14	Resistor: 2.2×10^{10} Ohms; 20%	High Megohm—X1	Victoreen	185-1370	185-1370	1	1
R15	Resistor: 2.2×10^{11} Ohms; 20%	High Megohm—X0.1	Victoreen	185-1377	185-1377	1	1
R16	Resistor: 2200 Ohms; .5W; 10%	Feedback Resistor	IRC	GBT-½	185-657	1	1
S1A	Switch Section	Battery Switch—ON—OFF	Victoreen	815-10	815-10	1	1
S1B	Switch Section	Signal Resistor Range Selector	———	——	——	—	—
S1C	Switch Section	Range Cal. Pot. Selector	———	——	——	—	—
T1	Transformer	Oscillator—Pwr. Supply	Victoreen	14-61	14-61	1	1
V1	Electron Tube: VX86	Ion Current Detector	Victoreen	35-134	35-134	1	5
BT1	Battery: 1.5V	dc Power Supply to Oscillator and 5886 Filament	Union Carbide Consumers Co.	#950	16-4	1	20
CR1	Diode: Silicon	Chamber Voltage Supply Rectifier	Victoreen	52-30	52-30	1	5
CR2	Diode	Plate Voltage Supply Rectifier	Victoreen	52-35	52-35	2	5
CR3	Same as CR2	Grid Bias Voltage Rectifier	Victoreen	——	——	—	—

*Quantity of Plant and Maintenance Supply Parts Based on Five Instruments For One Year of Operation.

9.2 Mechanical Components.

Description	Function	Manufacturer	Mfg. Part No.	Victoreen Part No.	Quantity for Equipment	*Quantity for Maintenance
Strap Buckle	Carrying Strap Length Adjustment	Waterbury Buckle Co.	807 5047	710-44	2	4
Strap Fastener	Attaches Shoulder Strap	Victoreen	815-47	815-47	2	4
Shoulder Strap	Carrying Strap	Victoreen	700-81	700-81	1	2
Case Bottom Ass'y.	Bottom of Instrument Case	Victoreen	815-30	815-30	1	2
Knob	Zero Adjust	Harry Davies Moulding Co.	1500-K	9-14	1	5
Battery Contact	Elect. Connections to Batteries	Victoreen	700-68	700-68	2	8
Battery Box	Holds Batteries	Victoreen	815-4	815-4	1	3
Ion Chamber Ass'y.	Radiation Detector	Victoreen	815-15	815-15	1	5
"O" Ring	Shaft Seal	Cleveland Ball Bearing Co.	5427-1	46-38	2	6

9.2 Mechanical Components (cont'd)

Description	Function	Manufacturer	Mfg. Part No.	Victoreen Part No.	Quantity for Equipment	*Quantity for Maintenance
Rubber Gasket	Switch Drive Shaft Gasket	Victoreen	44-48	44-48	1	5
Switch Drive Shaft	Connects Switch Index to Switch Wafers	Victoreen	815-33	815-33	1	3
Shield Box	Shields High Impedance Ckt.	Victoreen	815-22	815-22	1	1
Chamber Terminal Contact	Connects Ion Chamber to Elect. Tube Ckt.	Victoreen	815-19	815-19	1	2
Tube Socket	Holds Elect. Tube	Elco Mfg. Corp.	770-SCX	33-45	1	2
Gasket, Shield Box	Gasket Between Shield Box and Circuit Board	Victoreen	815-18	815-18	1	3
Ckt. Board, Processed	Supports Components	Victoreen	815-23	815-23	1	3
Knob	Range Control	Harry Davies Moulding Co.	——	9-9	1	2
Meter Gasket	Case Top-Meter Seal	Victoreen	700-63	700-63	1	5
Switch Index	Positions Range Switch	Victoreen	815-36	815-36	1	3
Case Top and Handle Ass'y.	Instrument Carrying Handle and Top of Instrument	Victoreen	815-25	815-25	1	3
Case Gasket	Case Top-Case Bottom Seal	Victoreen	720-157	720-157	1	10
Instruction Manual	Operating and Maintenance Manual	Victoreen	815-1	815-1	2	10

*Quantity of Plant and Maintenance Supply Parts Based on Five Instruments For One Year of Operation.

9.3 List of Manufacturers.

AEROVOX CORPORATION, 740 Belleville Avenue, New Bedford, Massachusetts
CLEVELAND BALL BEARING COMPANY, 3865 Carnegie Avenue, Cleveland 15, Ohio
CTS CORPORATION, 1142 Beardsley Avenue, Elkhart, Indiana
CTS OF ASHVILLE, Mills Gap Road, Skyland, North Carolina
ELCO MANUFACTURING CORPORATION, "M" Street, Philadelphia, Pennsylvania
JOHN E. FAST CO., 3580 Elston Avenue, Chicago, Illinois
GENERAL ELECTRIC COMPANY, LIVERPOOL, New York
HARRY DAVIES MOULDING COMPANY, 1428 North Wells Street, Chicago 10, Illinois
INTERNATIONAL RESISTANCE COMPANY, 401 North Broad Street, Philadelphia, Pennsylvania
RADIO MATERIALS CORPORATION, 3325 North California Avenue, Chicago, Illinois
UNION CARBIDE CONSUMERS COMPANY, 30 East 42nd Street, New York, New York
VICTOREEN INSTRUMENT COMPANY, 5806 Hough Avenue, Cleveland 3, Ohio
WATERBURY BUCKLE COMPANY, 862 South Main Street, Waterbury 20, Connecticut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